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Method for calculating the optimal number of BTSs in a cellular network and determining a loading factor value therefor

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ABSTRACT

A method is disclosed for calculating the number of base transceiver stations (BTSs) in a cellular network and for determining a loading factor value therefor. The method calculates the number of BTSs required to service a desired number of subscribers as a function of loading factor value. The method also calculates the number of BTSs required to cover a desired service area as a function of loading factor value. A value for the loading factor that minimises the difference between the number of BTSs required to service the desired number of subscribers and cover the service area. The required number of BTSs is then determined using this loading factor value.

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COMPLETE SPECIFICATION

STANDARD PATENT

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Invention Title: "Method For Calculating The Optimal Number of BTSs in a Cellular Network And Determining A Loading Factor Value Therefor"

The following statement is a full description of this invention, including the best method of performing it known to me:-

TITLE

Method For Calculating The Optimal Number Of BTSs In A Cellular Network And Determining A Loading Factor Value Therefor

FIELD OF THE INVENTION

The present invention relates to a method for calculating the optimal number of base transceiver stations in a cellular network and for determining a loading factor value therefor. The method is particularly useful to calculate the number of base transceiver stations required to satisfy both service area and subscribers when designing a cellular network.

BACKGROUND ART

In a cellular mobile telecommunication system, the total service area is divided into a plurality cells, each of which is controlled by a base transceiver station (BTS). These BTSs are controlled by a mobile switching center (MSC), which enables subscribers to maintain communication when moving between cells. BTSs are typically connected to the MSC by a wire link and the MSC is connected to another MSC or a public switched telephone network (PSTN).

In a cellular mobile telecommunication system, a mobile station's communication frequency is not fixed, but is automatically synchronised to a frequency designated by the BTS. In traditional cellular mobile telecommunication systems, neighbouring cells must use different frequencies to avoid interference, though cells far away can use the same frequency. Because the cellular mobile telecommunication system can reuse frequencies by dividing the service area into cells, it increases efficiency of frequency usage and can accommodate more subscribers.

A cellular mobile telecommunication system which uses code division multiple access (CDMA) can accommodate a plurality of subscribers on a single frequency by using codes. FIG. 1 shows the well-known structure of a typical CDMA network. In FIG. 1, base transceiver stations (BTSs) 10, 11, 12 and 13, base station controllers (BSCs) 20 and 21 and a mobile switching center (MSC) 30 are

As shown in the two examples, there is a big difference between the number of BTSs required to accommodate the given subscribers and the number of BTSs required to cover the given service area. This is because the chosen loading factor value may not be appropriate for the network morphology.

Because the prior art uniformly uses an arbitrary loading factor value regardless of the network criteria, it is impossible to calculate the number of BTSs required to accommodate the given subscribers and service area.

DISCLOSURE OF THE INVENTION

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

The present invention seeks to provide a method for calculating the optimal number of BTSs that will accommodate both a given subscriber amount and service area.

The present invention also seeks to provide a method for calculating an optimal loading factor value in a systematic manner, based on network criteria such as subscriber level and service area.

In accordance with a first aspect of this invention, there is provided a method for calculating the optimal number of base transceiver stations in a cellular network covering a service area, comprising the steps of:

calculating a first number of base transceiver stations required to service a desired number of subscribers as a function of a loading factor;

calculating a second number of base transceiver stations required to cover the service area as a second function of the loading factor;

selecting a value for the loading factor that minimises the difference between said first number of base transceiver stations and said second number of base transceiver stations; and

calculating the optimal number of base transceiver stations using the selected value for the loading factor.

Preferably, in said selecting step, said value for the loading factor is chosen at a position where the number of base transceiver stations required to service a desired number of subscribers coincides with the number of base transceiver stations required to cover the service area.

In accordance with a second aspect of this invention, there is provided a method for calculating the optimal value for a loading factor in a cellular network covering a service area, comprising the steps of:

calculating a first number of base transceiver stations required to service a desired number of subscribers as a function of the loading factor;

calculating a second number of base transceiver stations required to cover the service area as a second function of the loading factor;

selecting a value for the loading factor that minimises the difference between said first number of base transceiver stations and said second number of base transceiver stations.

Preferably, in said selecting step, said value for the loading factor is chosen at a position where the number of base transceiver stations required to service a desired number of subscribers coincides with the number of base transceiver stations required to cover the service area.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to two embodiments thereof and the accompanying drawings, in which:

FIG. 1 shows a code division multiple access cellular network;

FIG. 2 is a graph of the number of BTSs required for a given subscriber amount as a function of loading factor value;

FIG. 3 is a graph of the number of BTSs required to cover a given service area as a function of loading factor value;

FIG. 4 is a graph superimposing FIGs. 2 and 3 to determine a loading factor value;

FIG. 5 is a flow chart of the method for calculating the optimal number of BTSs in a cellular network according to the first embodiment of the invention; and

FIG. 6 is a flow chart of the method for calculating an optimal value for loading factor in a cellular network according to the second embodiment of the invention.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

The embodiments will be described with reference to determining the optimal number of BTSs for a code division multiple access cellular network. For the purposes of the embodiments, the cellular network is assumed to relate to a region C having 50,000 subscribers within a service area of 3,000km^2. The morphology of the region C is assumed to be 10% dense urban district, 20% urban district, 20% sub-urban district and 50% rural district. Further, it is assumed that 70% of the subscribers are in a sectored cell and the remaining 30% are in an omni-cell. It should be appreciated that the invention is applicable to networks with parameters different to those assumed for the purposes of illustrating the embodiments.

The first embodiment is directed towards a method for calculating the optimal number of BTSs in a cellular network. A flow chart of the method of the first embodiment is shown in figure 5.

The first step shown in figure 5 is to calculate the number of BTSs required to support the desired number of subscribers, or traffic (s11). The number of BTSs required to service the desired number of subscribers, or traffic, is calculated for a range of loading factor values. The results are presented in the graph shown in figure 2.

Next, the number of BTSs required to cover the service area is calculated (s12). Again, the number of BTSs required to cover the service area is calculated for a

range of loading factor values. The results for the region C are shown in a graph in figure 3.

Next, the method determines a value for loading factor that minimises the difference in the number of BTSs required to support the desired number of subscribers and the number of BTSs required to cover the service area (s13).

As can be seen from figures 2 and 3, the number of BTSs varies greatly with the loading factor. Simply arbitrarily selecting a value for the loading factor is unlikely to achieve an optimal result. Instead, the method of the embodiment selects a value for the loading factor where the graphs shown in figures 2 and 3 intersect.

Figure 4 is a graph in which the graphs shown in figures 2 and 3 have been superimposed. The graph from figure 2, representing the number of BTSs required to service the desired number of subscribers is labelled with the numeral 1. The graph from figure 3, representing the number of BTSs required to cover the service area is labelled with the numeral 2.

As seen in figure 4, the number of BTSs required to accommodate the desired number of subscribers and cover the service area meet at a position where the loading factor value is 60%. Therefore, 60% is determined as the optimal value for loading factor in the embodiment.

Finally, the method calculates the optimal number of BTSs (s14). From any one of figures 2, 3 or 4 it can be seen that the number of BTSs required is 100 when the loading factor value is 60%. It should be appreciated that the graphs shown in figures 2, 3 and 4 will vary according to the parameters of the network such as the desired number of subscribers and the service area as well as the morphology of the network.

The second embodiment is directed towards a method for determining an optimal value for loading factor in a cellular network. A flow chart of the steps in the method is shown in figure 6. The first step consists of calculating the number of BTSs required to service a desired number of subscribers (s21) in the same manner as described in relation to step s11 of the first embodiment. The next step is calculating the number of BTSs required to cover the service area (s22) in

the same manner as described in relation to step s12 of the first embodiment. Finally, an optimal value for the loading factor is determined (s23) in the same manner as described in relation to step s13 of the first embodiment.

It will be appreciated that the embodiments provide an advantage over the prior art in that a systematic method is adopted for determining the number of BTSs required for a network and the loading factor value used in the network. Further, the value for the loading factor is determined taking into consideration the desired number of subscribers and the desired service area.

While the invention is susceptible to various modification and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and detected description. It should be understood, however, that the present invention is not limited to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternative falling within the spirit and scope of the invention as defined by the appended claims.

THE CLAIMS defining the invention are as follows:

1. A method for calculating the optimal number of base transceiver stations in a cellular network covering a service area, comprising the steps of:

   calculating a first number of base transceiver stations required to service a desired number of subscribers as a function of a loading factor;

   calculating a second number of base transceiver stations required to cover the service area as a second function of the loading factor;

   selecting a value for the loading factor that minimises the difference between said first number of base transceiver stations and said second number of base transceiver stations; and

   calculating the optimal number of base transceiver stations using the selected value for the loading factor.

2. The method of claim 1, wherein in said selecting step, said value for the loading factor is chosen at a position where the number of base transceiver stations required to service a desired number of subscribers coincides with the number of base transceiver stations required to cover the service area.

3. The method of claim 2, wherein said value for the loading factor is selected as 60%.

4. A method for calculating the optimal value for a loading factor in a cellular network covering a service area, comprising the steps of:

   calculating a first number of base transceiver stations required to service a desired number of subscribers as a function of the loading factor;

   calculating a second number of base transceiver stations required to cover the service area as a second function of the loading factor;

selecting a value for the loading factor that minimises the difference between said first number of base transceiver stations and said second number of base transceiver stations.

5. The method of claim 4, wherein in said selecting step, said value for the loading factor is chosen at a position where the number of base transceiver stations required to service a desired number of subscribers coincides with the number of base transceiver stations required to cover the service area.

6. The method of claim 5, wherein said value for the loading factor is selected as 60%.

7. A method for calculating the optimal number of base transceiver stations in a cellular network covering a service area substantially as described herein with reference to figures 2 to 5 of the accompanying drawings.

8. A method for calculating the optimal value for loading factor in a cellular network covering a service area substantially as described herein with reference to figures 2 to 4 and 6 of the accompanying drawings.

Dated this twenty-fourth day of January 2001

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FIG. 1

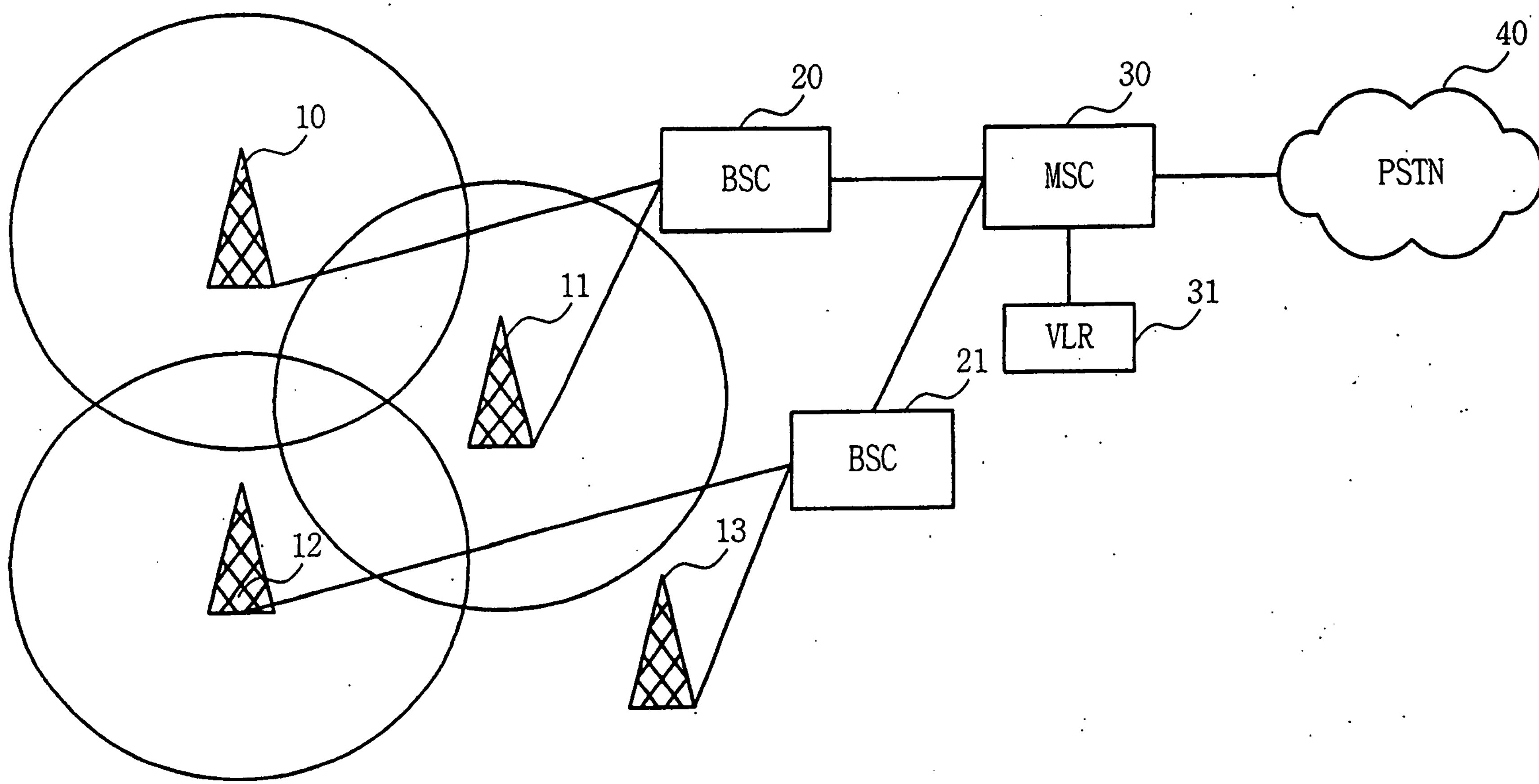

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FIG. 2

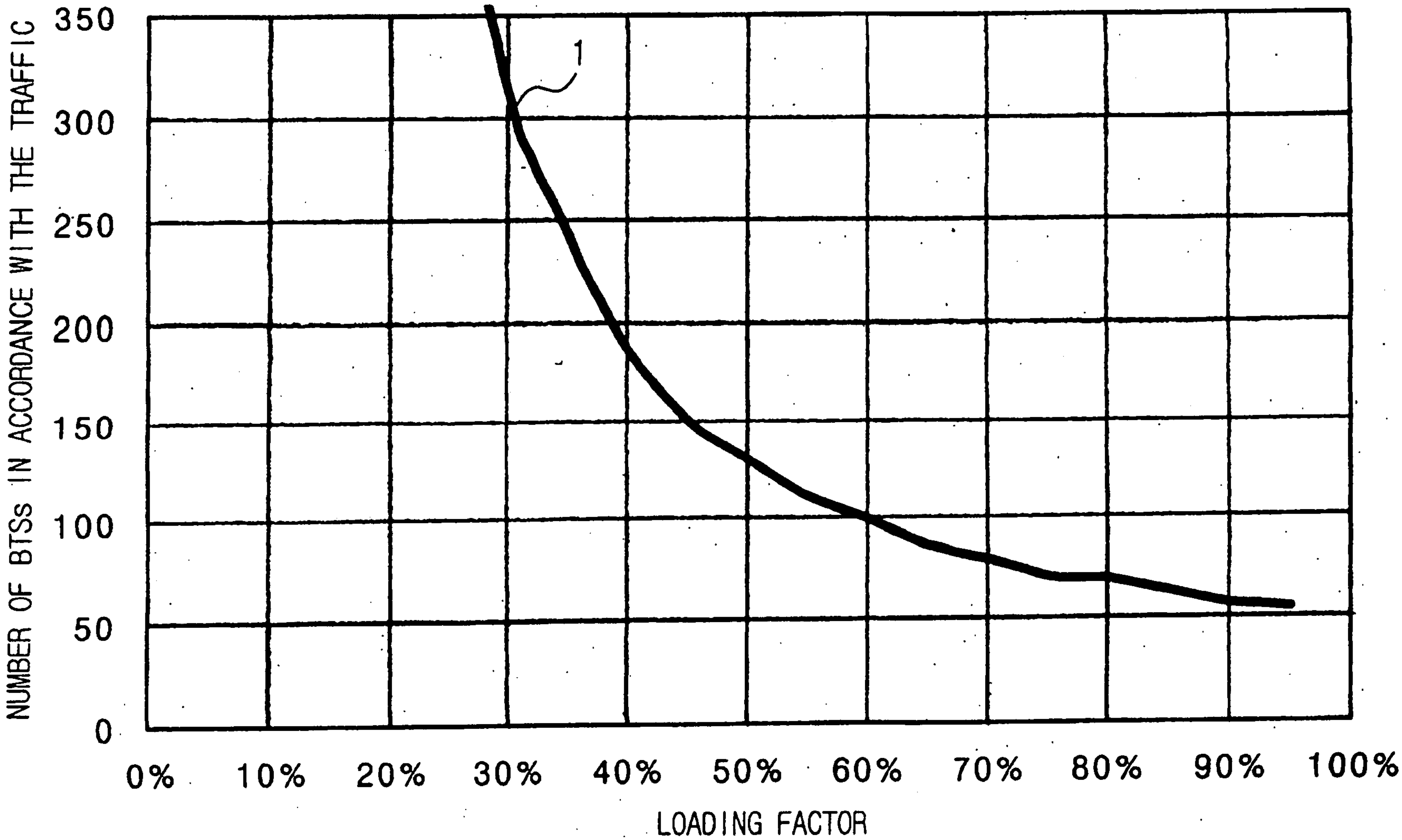


FIG. 3

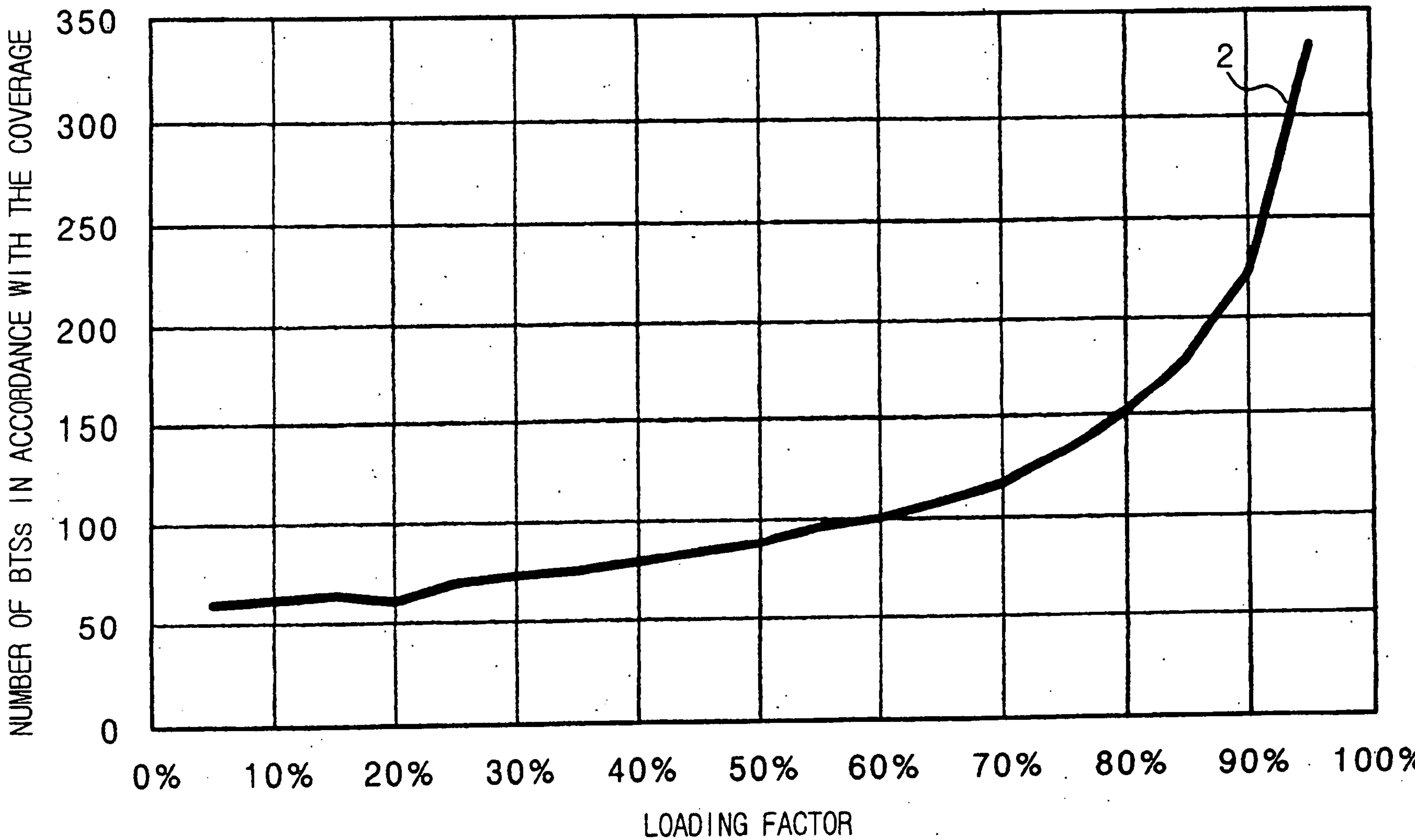

2
NUMBER OF BTSs IN ACCORDANCE WITH THE COVERAGE
350
300
250
200
150
100
50
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
LOADING FACTOR

FIG. 4

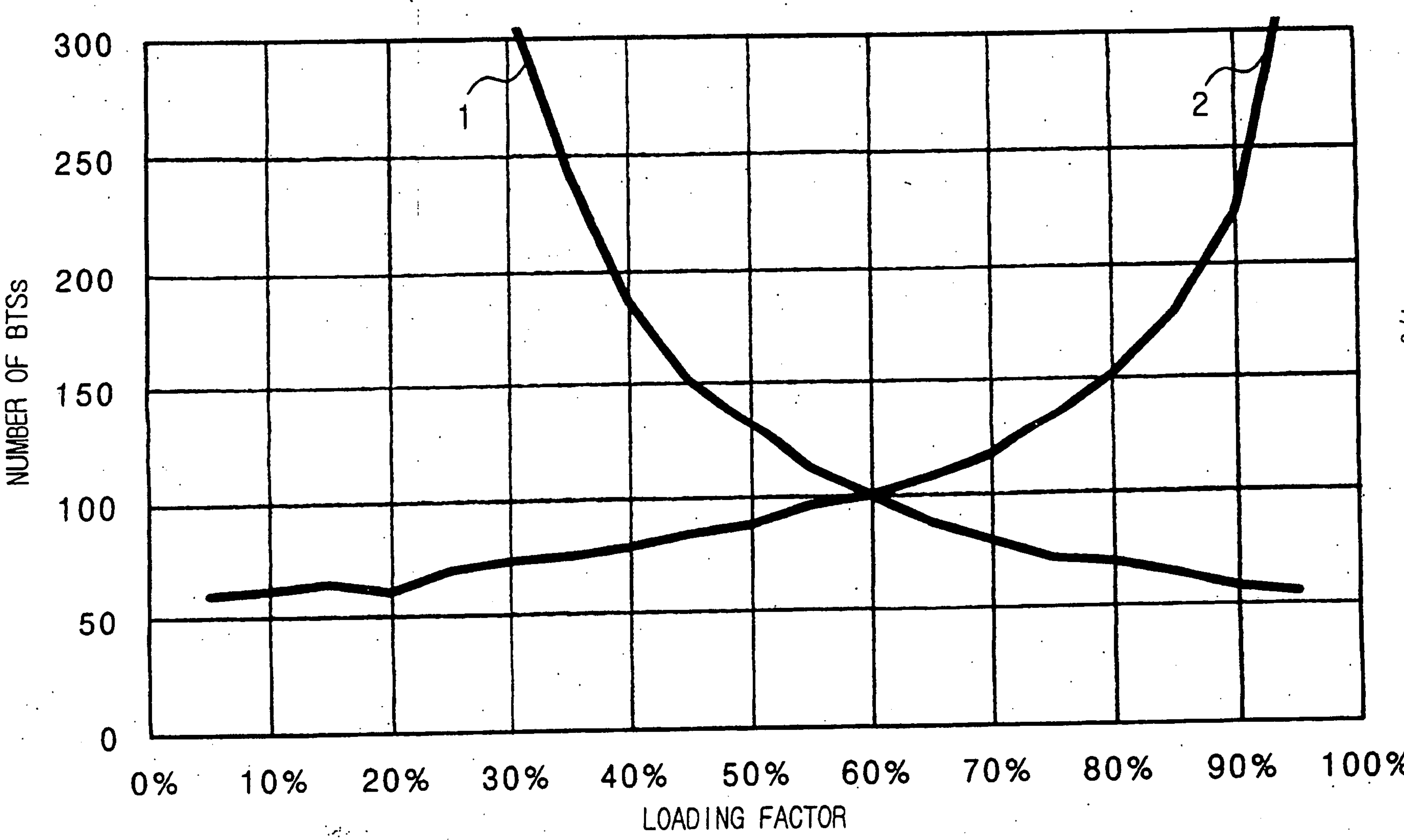

300
250
200
150
100
50
0
NUMBER OF BTSs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
LOADING FACTOR
1
2

FIG. 5

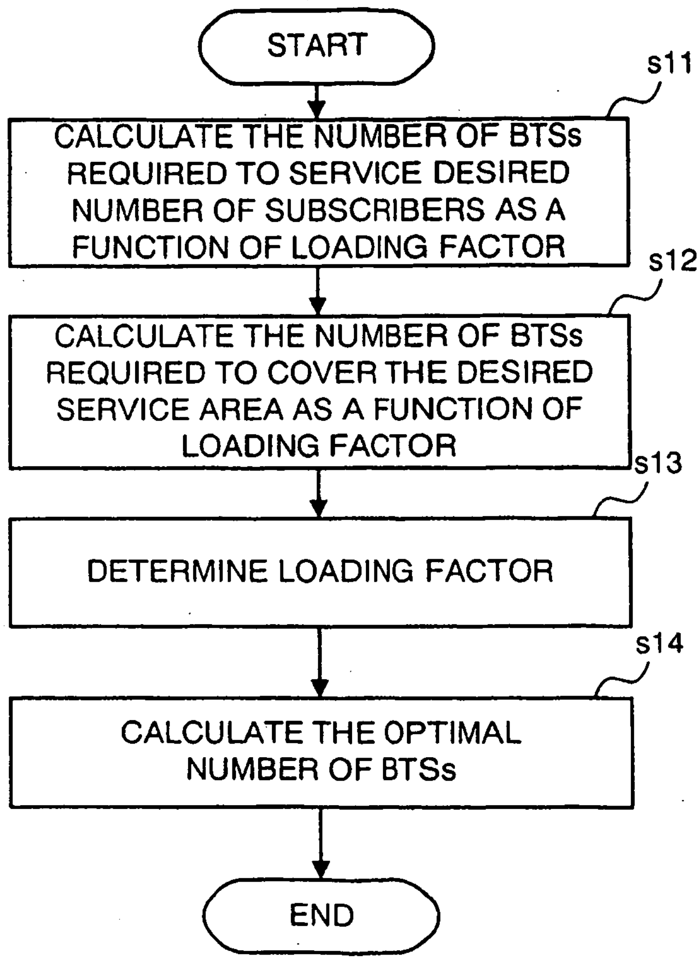
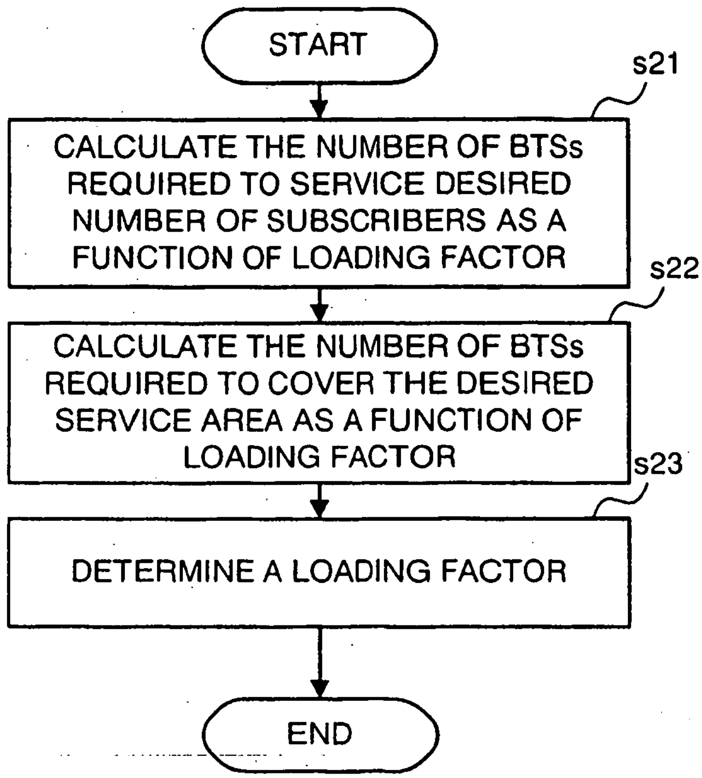

START
s11
CALCULATE THE NUMBER OF BTSs REQUIRED TO SERVICE DESIRED NUMBER OF SUBSCRIBERS AS A FUNCTION OF LOADING FACTOR
s12
CALCULATE THE NUMBER OF BTSs REQUIRED TO COVER THE DESIRED SERVICE AREA AS A FUNCTION OF LOADING FACTOR
s13
DETERMINE LOADING FACTOR
s14
CALCULATE THE OPTIMAL NUMBER OF BTSs
END

FIG. 6


START
s21
CALCULATE THE NUMBER OF BTSs REQUIRED TO SERVICE DESIRED NUMBER OF SUBSCRIBERS AS A FUNCTION OF LOADING FACTOR
s22
CALCULATE THE NUMBER OF BTSs REQUIRED TO COVER THE DESIRED SERVICE AREA AS A FUNCTION OF LOADING FACTOR
s23
DETERMINE A LOADING FACTOR
END